

CLAIMS

1. A DC-AC converter, comprising:

a transformer having a primary winding and at least one secondary winding;

a first and a second semiconductor switches connected in series via said primary winding for allowing current to flow from a DC power source through said primary winding in a first direction;

a third and a fourth semiconductor switches connected in series via said primary winding for allowing current to flow from said DC power source through said primary winding in a second direction;

a current detection circuit for detecting the current that flows through a load connected to said secondary winding to thereby generate a current detection signal;

a triangular wave signal generation circuit for generating a triangular wave signal;

a PWM control signal generation circuit for generating a PWM control signal by comparing said triangular wave signal with an error signal generated on the basis of said current detection signal;

an intermittent-operation control circuit adapted to set said error signal to a substantially zero level during an OFF period of said intermittent operation,

gradually increase the error signal upon transition from an OFF state to an ON state; and
gradually decrease the error signal upon transition from an ON state to an OFF state, and
a logic circuit that operates on the basis of said PWM control signal to generate

a first switch signal for turning on said first semiconductor switch;

a second switch signal for turning on said second semiconductor switch;

a third switch signal for turning on said third semiconductor switch; and

a fourth switch signal for turning on said fourth switch

in such a way that

a first simultaneously OFF period is established during which said first and fourth switches are simultaneously turned off, and a second simultaneously OFF period is established during which said third and second switches are simultaneously turned off, and that

the direction of the current flowing through said primary winding is changed from one direction to the other when the magnitude of said current is zero.

2. The DC-AC converter according to claim 1, wherein

said second switch is turned on at the point of time matched with every other apex of said triangular wave signal on one side thereof and remains turned on until a triangular signal that follows immediately after the turning on of said second switch becomes equal in magnitude to said error signal;

said first switch is turned on a first predetermined time before said second switch is turned on and remains turned on until a triangular signal that follows immediately after the turning off of said second switch reaches its apex on the other side of said triangular wave signal;

said fourth switch is turned on at the point of time matched with every other apex that is on the same side of, but is different from, said apices associated with the turning on of said second switch and remains turned on until a triangular signal that follows immediately after the turning on of said fourth switch becomes equal in magnitude to said error signal; and

said third switch is turned on a second predetermined time before said fourth switch is turned on while said second switch is turned off and said first switch is turned on, and remains turned on until a triangular signal that follows immediately after the turning off of said fourth switch reaches its apex on the other side of said triangular wave signal.

3. A DC-AC converter, comprising:

a transformer having a primary winding and at least one secondary winding;

a first capacitor and a first semiconductor switch connected in series via said primary winding for allowing current to flow from a DC power source through said primary winding in a first direction;

a second semiconductor switch and a second capacitor connected in series via said primary winding for allowing current to flow from said DC power source through said primary winding in a second direction;

a current detection circuit for detecting the current that flows through a load connected to said secondary winding to thereby generate a current detection signal;

a triangular wave signal generation circuit for generating a triangular wave signal;

a PWM control signal generation circuit for generating a PWM control signal by comparing said triangular wave signal with an error signal generated on the basis of said current detection signal;

an intermittent-operation control circuit adapted to set said error signal to a substantially zero level during OFF periods of the intermittent operation, gradually increase the error signal upon a

transition from an OFF state to an ON state; and

gradually decrease the error signal upon a transition from an ON state to an OFF state, and

a logic circuit that operates on the basis of said PWM control signal to generate

a first switch signal for turning on said first semiconductor switch and

a second switch signal for turning on said second semiconductor switch

in such a way that

a simultaneously OFF period is established during which said first and second switches are simultaneously turned off, and

the direction of the current flowing through said primary winding is changed from one direction to the other when the magnitude of said current is zero.

4. The DC-AC converter according to claim 3, wherein

said first switch is turned on at the point of time matched with every other apex of said triangular wave signal on one side thereof and remains turned on until a triangular signal that follows immediately after the turning on of said first switch becomes equal in magnitude to said error signal; and

said second switch is turned on at the point of time

matched with every other apex that is on the same one side, but is different from, said apices associated with the turning on of said first switch, and remains turned on until a triangular signal that follows immediately after said turning on of said second switch becomes equal in magnitude to said error signal.

5. The DC-AC converter according to any one of claims 1 through 4, wherein

said PWM control signal generation circuit includes an error signal generation circuit for generating an error signal based on the difference between said current detection signal and a current reference signal, and

a PWM comparator for comparing said triangular wave signal with said error signal to output a PWM control signal, and

said intermittent-operation control circuit has an intermittent-operation control element that is connected to said error signal generation circuit and controllably turned on/off by said intermittent-operation signal in such a way that said error signal has a substantially zero level during off periods of said intermittent operation.

6. The DC-AC converter according to claim 5, wherein

said error signal generation circuit generates said error signal based on the error output of an error amplifier that compares said current detection signal with said current reference signal, and

said intermittent-operation control circuit sets said current detection signal to a predetermined level to reduce said error signal to a substantially zero level.

7. The DC-AC converter according to claim 6, wherein

a capacitor is connected between the output end of said error signal generation circuit and the current detection signal input end of said error amplifier, and

said capacitor is discharged upon transition from an ON state to an OFF state of said intermittent-operation signal to reduce said error signal towards zero level, and charged upon transition from an OFF state to an ON state of said intermittent-operation signal to increase the level of said error signal.

8. A control IC for supplying AC power to a load connected to a secondary winding of a transformer by driving a switch circuit that includes: a first and a second semiconductor switches connected in series via said primary winding of said transformer to cause current to flow from a DC power source through said primary winding in a first direction;

and a third and a fourth semiconductor switches connected in series via said primary winding to cause current to flow from said DC power source through said primary winding in a second direction, said control IC comprising:

a triangular wave signal generation circuit for generating a triangular wave signal;

a PWM control signal generation circuit for generating a PWM control signal by comparing said triangular wave signal with an error signal formed on the basis of a current detection signal for the current flowing through said load;

an intermittent-operation control circuit adapted to set said error signal to a substantially zero level during an OFF period of said intermittent operation, gradually increase said error signal upon transition from an OFF state to an ON state, and gradually decrease said error signal upon transition from an ON state to an OFF state; and

a switch signal generation logic circuit that operates on the basis of said PWM control signal to generate a first, a second, a third, and a fourth switch signals for respectively turning on said first, second, third, and fourth semiconductor switches, in such a way that a first simultaneously OFF period is established during which said first and fourth switches are simultaneously turned off and

a second simultaneously OFF period is established during which said third and second switches are simultaneously turned off, and that the direction of the current flowing through said primary winding is switched from one direction to the other when the magnitude of the current is zero.

9. The controller IC according to claim 8, wherein

said second switch is turned on at the point of time matched with every other apex of said triangular wave signal on one side thereof and remains turned on until a triangular signal that follows immediately after the turning on of said second switch becomes equal in magnitude to said error signal;

said first switch is turned on a first predetermined time before said second switch is turned on and remains turned on until a triangular signal that follows immediately after the turning off of said second switch reaches its apex on the other side of said triangular wave signal;

said fourth switch is turned on at the point of time matched with every other apex that is on the same side of, but is different from, said apices associated with the turning on of said second switch and remains turned on until a triangular signal that follows immediately after the turning on of said fourth switch becomes equal in magnitude to said error signal; and

said third switch is turned on a second predetermined time before said fourth switch is turned on while said second switch is turned off and said first switch is turned on, and remains turned on until a triangular signal that follows immediately after the turning off of said fourth switch reaches its apex on the other side of said triangular wave signal.

10. A controller IC for supplying AC power to a load connected to a secondary winding of a transformer by driving a switch circuit that includes: a first capacitor and a first semiconductor switch connected in series via said primary winding of said transformer to cause current to flow current from a DC power source through said primary winding in a first direction; and a second semiconductor switch and a second capacitor connected in series via said primary winding to cause current to flow from said DC power source through said primary winding in a second direction, said control IC comprising:

a triangular wave signal generation circuit for generating a triangular wave signal;

a PWM control signal generation circuit for generating a PWM control signal by comparing said triangular wave signal with an error signal formed on the basis of a current detection signal for the current flowing

through said load;

an intermittent-operation control circuit adapted to
set said error signal to a substantially zero
level during an OFF period of the intermittent operation,
gradually increase said error signal upon
transition from an OFF state to an ON state, and
gradually decrease said error signal upon
transition from an ON state to an OFF state; and

a switch signal generation logic circuit that operates
on the basis of said PWM control signal to generate a first
switch signal for turning on said first semiconductor switch
and a second switch signal for turning on said second
semiconductor switch in such a way that a simultaneously
OFF period is established during which said first and
second switches are simultaneously turned off and that the
direction of the current flowing through said primary
winding is switched from one direction to the other when the
magnitude of said current is zero.

11. The DC-AC converter according to claim 10, wherein

said first switch is turned on at the point of time
matched with every other apex of said triangular wave
signal on one side thereof and remains turned on until a
triangular signal that follows immediately after the
turning on of said first switch becomes equal in magnitude

to said error signal; and

said second switch is turned on at the point of time matched with every other apex that is on the same one side of, but is different from, said apices associated with the turning on of said first switch, and remains turned on until a triangular signal that follows immediately after said turning on of said second switch becomes equal in magnitude to said error signal.

12. The controller IC according to any one of claims 8 through 11, wherein

said PWM control signal generation circuit includes
an error signal generation circuit for
generating an error signal based on the difference between
said current detection signal and a current reference signal,
and

a PWM comparator for comparing said
triangular wave signal with said error signal to output a
PWM control signal, and

said intermittent-operation control circuit has an
intermittent-operation control element that is connected to
said error signal generation circuit and controllably turned
on/off by said intermittent-operation signal in such a way
that said error signal has a substantially zero level during
off periods of said intermittent operation.

13. The DC-AC converter according to claim 12, wherein

said error signal generation circuit generates said error signal based on the error output of an error amplifier that compares said current detection signal with said current reference signal, and

said intermittent-operation control circuit sets said current detection signal to a predetermined level to reduce said error signal to a substantially zero level.

14. The DC-AC converter according to claim 13, wherein

a capacitor is connected between the output end of said error signal generation circuit and the current detection signal input end of said error amplifier, and

said capacitor is discharged upon transition from an ON state to an OFF state of said intermittent-operation signal to reduce said error signal towards zero level, and charged upon transition from an OFF state to an ON state of said intermittent-operation signal to increase the level of said error signal.

15. An electronic apparatus, comprising:

a DC power source;

a DC-AC converter connected to said DC power source for outputting an AC power according to any one of claims

1 through 7, and

a light emitting device driven by the AC power
outputted from said DC-AC converter.

16. The electronic apparatus according to claim 15, wherein
said light emitting device is a CCFL.